

The Development of The Trolley Bus



by Harold Brearley

Locomotion Papers Number Eleven

Published by the Oakwood Press



Price Five Shillings

THE DEVELOPMENT OF
THE TROLLEY BUS

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South Godstone, Surrey:
THE OAKWOOD PRESS
1957

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PRINTED IN ENGLAND BY
THE ESPERANTO PRINTERS LTD., CHORLEYWOOD

PUBLISHER'S NOTE

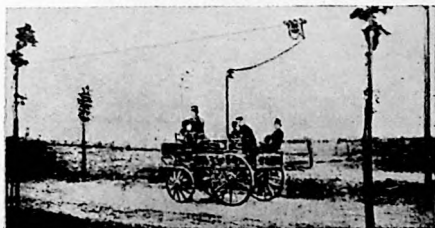
THE trolley bus has attracted less attention from historians than either the tramcar or the bus. The reason is not far to seek; it is a hybrid vehicle, fancy-free as to its wheels but dependent for its power on aerial leading-strings. Most people regard its installation simply as an expedient to enable an authority with insufficient cash for relaying its tramlines to still get some further usage out of the capital equipment. But is this the right view? Mr. Brearley shows that in its inception it was by no means regarded as a cheap substitute for trams. This booklet does not pretend to be a complete history of the trolley bus; but it does put a good many interesting facts on record. The author has spent many years in the mechanical department of the Bradford Corporation's trolley bus fleet. He is not a writer, and some indulgence may be asked of the reader on grounds of style. But he knows what he is talking about, and having read his story, many people will conclude that had the roads been better, and pneumatic tyres more robust, before the 1914-18 War, trackless road vehicles might well have made themselves a much more important niche in public transport in the United Kingdom and elsewhere.

THE DEVELOPMENT OF THE TROLLEY BUS

by H. Brearley

THE first street tramway was opened in New York in 1832, with horse traction, and in 1842 horse trams were used in Vienna to carry the public to an exhibition. In 1860 George Train built tramways in England, in Birkenhead and London. As early as 1847 Werner von Siemens conceived the idea of railless traction, with overhead trolleys which would collect electricity from wires. This carriage was put on show in Berlin on 29 April 1882; it was nothing like a tramcar and in fact resembled some weird contraption from a Jules Verne novel. But the principle was there: it was fed with electric power from an overhead line, and

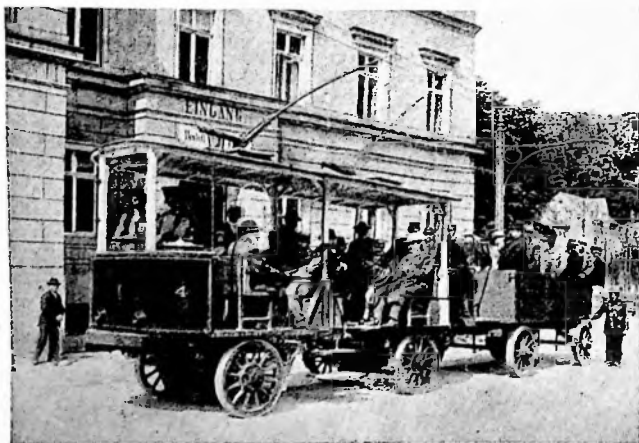
The father of all trolley buses; a peculiar vehicle run in Berlin by Werner Von Siemens on 29 April 1882.



the earth return was to another overhead line—in other words two trolleys on cables. In 1899 the firm of Siemens & Halske made and exhibited a hybrid electric motor bus with batteries, a tram-bow-collector, and a pair of flanged wheels like a bogie which ran in the groove rails, in front of the leading bus wheels. Each wheel had its own motor. The bus was intended to work with the flanged wheels lowered when over the tram-tracks using the bow-collector to drive it and charge the batteries at the same time. At the end of the line, the bus would run on powered by its batteries, with the flanged wheels raised.

In 1900 the idea of railless traction reached France, and at the Paris Exhibition a railless bus built by Lombard

Gerion was on show: an ambitious vehicle in which the trolley ran on top of the overhead lines, powered by its own motor. But it found little favour: the overhead gear was complex and the wires were continually breaking. Next year there appeared in the picture Max Schiemann, the brightest star in the trolley bus firmament; to him goes the credit for devising an entirely new method of current collection. He realised that the bow collector could not be used



Schiemann car with coal-wagon trailer in service at Bielethal in 1902.

for railless vehicles, and his discovery was a slide contact running under the wire. His vehicle had trolley poles, and in this way was able to be steered with fair reliability.

In 1903 Schiemann and Siemens working together produced the first vehicle of a type which remained standard until the 1914-18 War. Already body and chassis were separate units; the driver was seated, and steering was by stub axles; tramcar mechanisms were employed for switches, controls and gears, though they were somewhat modified. In front of the driver were two horizontal wheels; the top one actuated the controller, the lower one was for steering. Such an idea would scarcely satisfy today, but it was very progressive in 1903. Drive was to the rear wheels, through

double gears. Speed on the level was 14 kilometres (8.5 miles) per hour, and the weight was $3\frac{1}{2}$ tons.

In 1907 in Austria the Daimler company brought out a new type of railless vehicle, the Mercedes-Stoll. In essentials it was similar to the Siemens; a four-wheeled trolley rested on the wires and was connected to the bus by a flexible cable; a normal tramcar motor was used, and there was an electrical short-circuit brake. (There were two separate brakes both actuated by foot pedals, so the drivers needed to be acrobats.) The main feature was an improved motor, inside the wheel hub, making front-wheel drive possible (at Judenburg four-wheel drive was used).

In 1909 a Schiemann system was put in at Drammen in Norway, which continued to work in its original state until 1942. It was in the same year that 'railless' came to England, when a single-deck bus by the Railless Electric Traction Co. of Leeds was tried inside the Hendon depot of the Metropolitan Electric Tramways of London. It never ran in public service, and it was left to Leeds and Bradford to be the true pioneers, when on 24 June 1911 they introduced a trackless car service with Schiemann system under-running trolleys; from here grew the whole development of

A German trolley system in 1908.



trolley buses in the United Kingdom. Before discussing this, however, let us see how development progressed in the countries of the trolley bus's origin.

In Austria there were six early undertakings, with route mileages as shown: 1907, Gmünd station to Gmünd Town ($1\frac{5}{8}$ miles); 1908, Klosterneuburg-Weidling-Weidling Station ($2\frac{3}{8}$ miles); 1908, Vienna Potzleinsdorf to Salmansdorf ($1\frac{1}{2}$ miles); 1909, Liesing to Kalksburg ($2\frac{3}{4}$ miles); 1909, Pressburg to Weidritztal ($3\frac{3}{4}$ miles); 1910, Judenburg Station

to Judenburg Town (1½ miles). About twenty passenger vehicles were in use and one goods service vehicle.

German development falls into two well-defined periods, the first from 1901 to 1919, and the second from 1930 to date. During the years before the First World War many systems came into being, but most were in operation for a few years only, being replaced by tram and motor bus services. The first was opened on 10 July 1901, at Bielefeld in Saxony, and ran until 1904. There followed: Dresden 1902-1904, Langenfeld-Mannheim 1904-1908, Bremen 1904-1906, Grevenbrück-Bilstein 1904-1917, Badneuenheim 1906-1919, Ludwigsburg 1910-1914, Bremen 1910-1916, Heilbronn 1911-1916, Blankensee 1911-1914, Breslau 1912-1913, Berlin-Steglitz 1912-1914. Some of these lines handled goods as well as passengers; for instance Langenfeld-Mannheim had a railless locomotive capable of hauling four trailers (this line was replaced by a light railway). There were four systems too which handled goods only; of these Grevenbrück-Kalkbain and Bobeln-Mühlenbahn were short-lived; one at Wurzen in Saxony started in 1905 lasted until 1929, and the fourth, a short line at Hamburg Altona from the fish market to the harbour, started in 1911 and, as far as is known, is still working.

Interest in railless traction was reawakened when, about 1929, the firm of Rheinisch Westfälische Elektrizitätswerke, Essen drew up plans for a trolley bus system to be operated on one of its tramway routes, and a deputation came to the north of England to study the trolley systems in operation. An experimental system was equipped between Mettmann and Gruitten, east of Düsseldorf, and opened to traffic on 26 August 1930. It was operated with six-wheeled single-deck cars by the RWE company, and was taken over by the Rheinische Bahngesellschaft of Düsseldorf, becoming Route 59 on this system. When its success had been demonstrated other systems followed: Idar-Oberstein in 1932 and Berlin-Spandau in 1933. In 1936 Oldenburg began to convert its bus routes to trolley routes, and many tramways also converted single routes. Then came the Second World War, and by 1941 Dortmund, Hanover, Koblenz, and Leipzig all had trolleys. Similar developments occurred in Austria.

In 1942 apparently official consideration was given to the scrapping of buses to save oil, and some trolleys were obtained from Italy. Some from Milan were put into service

at Esslingen near Stuttgart; some went to towns that had never before had trolleys, such as Bielefeld, Kassel, Kiel (also Innsbruck in Austria). This shows the lengths to which the Germans were willing to go to save oil, for the new routes must have used much valuable copper for the conductors, even though the standards were of concrete or wood. A number of four-wheeled Russian trolleys also



151-seat articulated trolley bus in East Germany, 1955.

arrived and were put into service at Posen and Königsberg, and possibly Liegnitz and Waldenburg in Silesia (all these towns have since passed to Poland). The wartime raids played havoc with transport systems; in general the tramways were repaired before the trolley routes, but by 1947 great efforts were being made to put them back and wire was again in production. That completes the outline of the trolley bus in the countries that saw its birth; we must now return to the United Kingdom to see the development there from small beginnings.

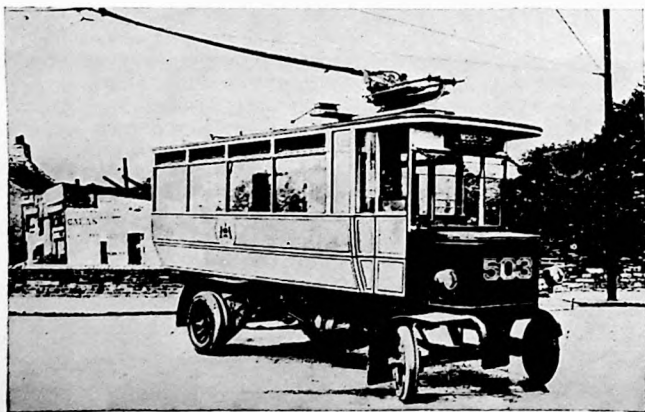
'RAILLESS' IN THE U.K.

THE experimental MET trolley bus of 1909, already mentioned, was open-fronted without any protection for the driver, and was chain-driven from a motor slung under the chassis. The trolley head was of a peculiar construction: both heads were joined together, with two separate booms. This bus, which, as stated, never went into public service, was all that London was to see of trolley buses for the time being, except for a brief experiment with a Cedès-Stoll car in West Ham.

And so to 1911, when Leeds and Bradford both decided, after a lot of red tape had been unwound, and deputations

sent to see trolley buses running (Germany would be the nearest, a nice holiday for one or two!) that they would put trackless cars into service. Why they did so is not clear; the trams were running well and making a nice profit, and the departments were expanding. And those early trolley buses were horrible to ride in, with their solid tyres and bad roads. It was said that the folk living in Sticker Lane district of Bradford had to screw their ornaments down because of the vibration when the trolleys went past!

On Tuesday 24 June 1911 Leeds Corporation started their railless service from City Square to Old Farnley via Aire Street and Whitehall Road. Four cars were purchased from the Railless Electric Traction Co. of Leeds, using the Schiemann system of two trolley booms. They were numbered in the 500's, and No. 503 was the first in service.



Leeds City Tramway Car No. 503 of 1911.

Four years later, on 8 September 1915, two more routes were opened, from Guiseley to Otley and Guiseley to Burley in Wharfedale. Strangely enough, these two routes, ideal for trolley running, were a long way from the City of Leeds and the City boundary. But they were probably

chosen because of the tram shed at White Cross, the starting point of the two routes. Four more buses were purchased at this time, and probably shedded at White Cross.

On 5 September 1921 No. 510 was put into service, a double-deck with front wheel drive, and this was not withdrawn until 21 December 1925, so it must have had a measure of success, but in appearance it was a monstrosity, the body having a distinctly tram flavour. Front wheel drive was also used in a remarkable vehicle purchased in 1925, a 64-seater with totally enclosed body which had been on



*Leeds City
Tramways
No. 510, a
front-wheel-
drive Rail-
less vehicle
of 1921.*

exhibition at Bournemouth; it was built by Trackless Cars Ltd. of Leeds, and was very nice looking. There were also three front-wheel-drive 55-seaters by Railless with open platforms, the bodies being built by the Transport Department at Kirkstall Road Works. One further bus was put into service after the Farnley route closed: a four-wheel Garrick centre-entrance single-deck which had a life of barely two years.

In 1938 the decision was taken to scrap the system, as the equipment was nearing the end of its useful life, and the policy was to develop the diesel bus. So we have seen the last of one of the pioneers of railless transport.

BRADFORD

We now come to Bradford, which started in June 1911 with two trackless cars (Nos. 240 and 241) with the under-running trolleys of the Schiemann system. The route was from Laisterdyke to Dudley Hill (1 mile 460 yards) and trolleys have run on it ever since, although it was extended in 1914 from Dudley Hill to Bankfoot and from Laisterdyke to Bolton, making a mileage of 4 miles 1,279 yards. On 25 June 1914 a further route was opened from Odsal to Oakenshaw (1 mile 1,122 yards) and on 11 March 1915 from Forster Square to Bolton Woods (2 miles 1,232 yards). The First World War was a difficult period; some vehicles were laid up and manpower was withdrawn for the Forces, so it was quite a few years before another trackless route was opened. This was Clayton route, opened on 4 September 1926, followed on 24 October 1927 by an extension of the Oakenshaw route into the centre of the City, thus giving through running from Clayton to Oakenshaw. On 1 December 1929 trolley cars of a new type came on the scene: six-wheel double-deckers to replace trams on the Allerton route—the first in Bradford to have trams replaced by trolleys—which extended 3 miles 1,359 yards from the city centre. Trams were again displaced on 30 March 1930, when trolleys took over from Saltaire to Thackley (6 miles). Another extension of the system came on 21 March 1931, to Green Gates via Idle, a branch of the Saltaire route 1 mile 990 yards long. Lidget Green was the next, on 12 December 1934 (the circle at Pasture Lane was not opened until 25 February 1951). The distance is 1 mile 994 yards.

The Bolton section became completely devoid of trams on 30 May 1934 when the Eccleshill route (2 miles 445 yards) was converted. On 25 November 1934 the Thornton route (4 miles 1,709 yards) was converted, and this took the trams off another side of the City. To complete yet another sector, Duckworth Lane was converted on 2 October 1935, and extended to Royal Infirmary 20 April 1936 (2 miles 104 yards). Across the City, Dudley Hill and Tong Cemetery (3 miles 5 yards) had trolleys on 6 July 1938, and Forster Square to Cross Flatts via Manningham Lane (6 miles 1,694 yards) on 7 May 1939.

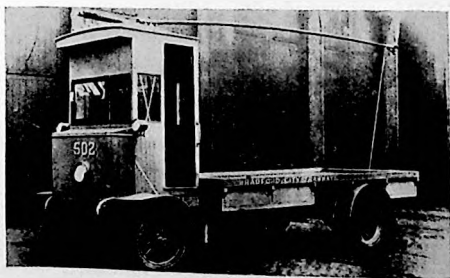
Full conversion had nearly been achieved, but as war clouds gathered again plans had to be put away, and for

five years there was a standstill; trams were even brought back on one route. After it was all over, conversion began again, with the Bradford Moor route on 4 December 1949 (1 mile 1.504 yards). The next route was opened after the final abandonment of the trams, which took place on 7 May 1950: this was Thornbury (2 March 1952; 2 miles 164 yards), a conversion from motor bus, as was also the Wibsey route (24 April 1955). And there may be more changes to come.

As Bradford has been more than any other town the pioneer in trolley bus operation, we will consider in some detail the buses operated, and some of the experiments from the Thornbury Works.

Nos. 240-241 (later renumbered 501-502): Schiemann type, single deck. Height of bus to roof 10 ft. 6 in., height of driver's platform 3 ft. 6 in., length of driver's compartment 4 ft. 3 in., length of body 15 ft. 0 in., overall length 20 ft. 3 in., overall width 7 ft. 0 in., wheelbase 13 ft. 0 in., seating capacity twenty-eight. Two mechanical brakes, one connected to the countershaft worked by foot pedal, the other consisting of a drum brake on the rear axle worked by either foot pedal or hand lever. Motors: two 20 b.h.p., 525 V., 1,050 r.p.m., by Siemens, series-wound with shunted fields and provided with commutating poles. Wool-waste oil lubrication. Control: hand-control of Siemens series-parallel magnetic blow-out type, with arrangements for cutting out either motor. No rheostatic braking; the main

*One of the
two Bradford
trolleylorries.*



barrel had nine positions in addition to the 'off', the reversing barrel six positions, as follows:

<i>Position</i>		<i>Main Barrel</i>	
1	Motors in series.	Full field.	Resistance in, reduced.
2	Motors in series.	Full field.	Resistance in, reduced.
3	Motors in series.	Full field.	Resistance in, reduced.
4	Motors in series.	Full field.	Resistance all out.
5	Motors in series.	Field shunted 50%.	
6	Motors in parallel.	Full field.	Resistance all out.
7	Motors in parallel.	Full field.	Resistance all out.
8	Motors in parallel.	Field shunted 25%.	
9	Motors in parallel.	Field shunted 50%.	

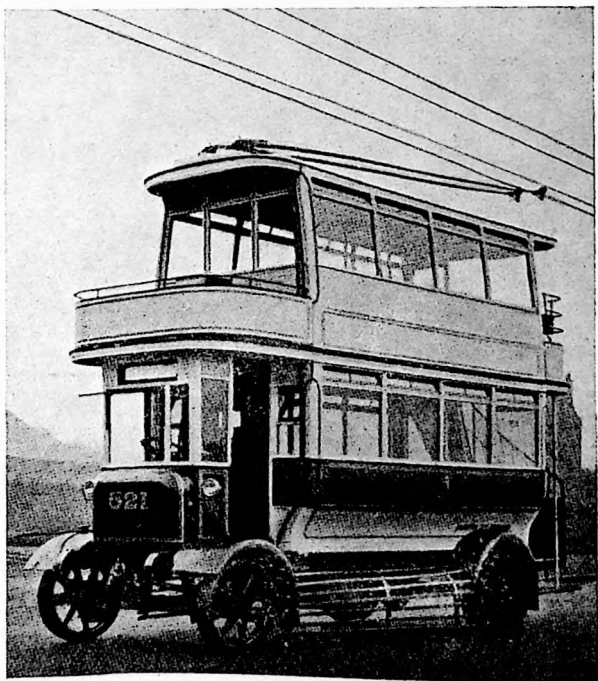
<i>Position</i>		<i>Reversing Barrel</i>	
1	Forward.	No. 1 motor cut out.	
2	Forward.	No. 2 motor cut out.	
3	Forward.	Both motors in.	
1	Backward.	Both motors in.	
2	Backward.	No. 2 cut out.	
3	Backward.	No. 1 cut out.	

Each motor drove one rear wheel through worm and chain gearing; the former worked in an oil bath and the chains were of the roller type totally enclosed. The front entrance body was by Hurst Nelson. Total unladen weight 3 tons 12 cwt. High voltage lighting (five 110 V. lamps in series). The wheels were of artillery pattern with solid rubber tyres. The trolleys (by the Railless Electric Traction Co.) were underrunning; the skate was hinged to the chassis, enabling the bus to run without the negative trolley, by earthing to a tram rail. No. 502 was ultimately rebuilt as an electric battery-cum-trolley lorry. Between 1912 and 1920 buses were built numbered up to 520 of a similar type, with bodies built by the Corporation.

Then came something different, No. 521, a covered top double-decker. There had been at least two other double-deckers built elsewhere (of which more later) but this was the first in the country, and probably in the world, to have a covered top: a great lumbering vehicle like something from the prehistoric world, but it did its job and paved the way to the buses of today. No. 521 was taken out of service in 1928. Here are some details:

Clear height in lower saloon 6 ft. 0 in., in upper saloon 5 ft. 6 in., height over roof 15 ft. 4 in., height to top of trolley standard 16 ft. 4 in., weight on front wheels unladen

2 tons 11 cwt., on rear wheels 4 tons 17 cwt., total 7 tons 8 cwt. (much the same as the present Bradford buses). Length of vestibule 4 ft. 0 in., length of body 13 ft. 6 in., length of platform 4 ft. 6 in., overall length 23 ft. 1 in., extreme width over mudguards 7 ft. 10 in., doorway 1 ft. 8 ins., wheelbase 13 ft. 0 in., seating capacity twenty-five in lower saloon and twenty-six in upper saloon, total fifty-one. Rheostatic brake, acting on countershaft and rear wheels by foot pedal; wheel brake acting on rear wheels only. One 45 h.p. Dick Kerr motor, hand control (four notches) drive by gear and chain 4.97 to 1. Speed 18 m.p.h. on



Bradford Corporation's first covered-top double-decker.

level, consumption 1.5 units per car mile. Lighting high voltage; body built by the Corporation.

The next bus, No. 522, was similar except that it had four-wheel steering and no rheostatic brake. There was one 70 h.p. Met-Vick series motor. Nos. 523-528 represented a return to single-deck; they were of front entrance type designed for pay-as-you-enter. Mechanically they were of a more advanced type, with one Dick Kerr 45 h.p. 31B ventilated tramway motor, hand control (four notches) worm and wormwheel drive, with a hollow propeller shaft connected to the motor. The doors were operated by the driver with a foot-pedal.

Then Bradford purchased some single-deck cars from Associated Daimler; these had pneumatic tyres and were a considerable advance in looks and design. Numbers: 529, 530, 531; seating capacity thirty-seven; Bull motors, foot control (six notches).

Nos. 532, 533, 534 were Garretts, with 50 h.p. BTH motors having foot control (seven notches). No. 535 was a Garrick with both trolley booms on one central base; 536 was painted maroon and may have come from Keighley; Nos. 537, 538, 539 were front entrance Garricks, 540 an ADC painted red, 541, 542, 543 front-entrance ADC's; 544-560 were single-deck Leylands, with no air brake, push-on handbrake, and rheostatic and foot brake on the transmission. Nos. 561-571 were English Electric single-deckers, with air brake. They were good to handle as against the Leylands where the braking was exceedingly hard, but control was manual and driving was hard work for the short-legged man. On the other hand the cab was very small, and the long-legged driver had his knees under his chin.

In 1929 came the huge and ugly English Electric six-wheel double-deckers (Nos. 572-583). They were monsters compared with the little pups the drivers had been used to, but were still controlled by foot pedal, and drivers had to pedal nine notches up and down for every start and four notches on the rheostatic brake for stopping. A full day with one of these and you pedalled in your sleep!

Equally big and clumsy were Nos. 584-596, English Electric 1930, but they were a decided advance, being the first contactor type (there had been experiments with No. 582), and after manually operated control there was as much difference in driving as there is between winding a

grandfather clock and a delicate wrist-watch. There was no stop between notches, so a driver had to be careful; if he had big feet they might all go on together—and out would come the breakers. The rheostatic brake was on the air brake pedal (two notches), but the snag was a small pedal between the power and brake pedals; if you did not depress this after using the brake there was no power to start again; many a time has a fitter been called out to 'no power', simply pressed the little pedal, and cursed the driver. But they were good buses.

In 1934 delivery began of a new type: four-wheel English Electric with twin rear tyres—smart looking vehicles. They were of the regenerative type, with brake and power on the same pedal; you *could* get the two mixed up and then the fun began: dead stop or a buck-jumping bus! Also, the main circuit breakers were on top of the bus operated by Bowden cable; your switches would go out quietly and the switch handle did not move. They were numbered 597–632.

Of another type still was No. 633, a Q-type front-entrance English Electric with four single wheels; a tricky bus in frost or ice but nice to handle in normal conditions. This bus went to South Shields; only five double-deckers of this design were built: it was before its time.

We now come to a design the shape of which became more or less the standard: of this group 634 and 635 were slightly different in bodywork, but Nos. 636 to 676 were alike as peas in a pod. They were four-wheel English Electric-AEC's with twin rear tyres, one motor, contactor control, and rheostatic brake. They were good buses—and still are after twenty years. Nos. 677–692 (Karriers with Weymann body and E.E. equipment) followed between 1935 and 1939; somehow they were a bit different and some drivers never liked them.

In 1942 came another new type, Sunbeam-BTH Nos. 693–702. These were 8 ft. wide, having been ordered for South Africa, and were Bradford's first wide buses. The bodies were Weymann; they had regenerative braking. They were withdrawn from service to be rebodied and now in 1956 are back at work with East Lancashire bodies, as good as ever. Nos. 703–739 were post-war 'utility' Karriers with Roe and Park Royal bodies, 7 ft. 6 in. wide double-deckers. They had high-voltage lighting: a step back this, for these lights, being in series, can sometimes be a nuisance. From 1949 to 1951 deliveries of the new BUT 8 ft.-wide

trolley buses were coming along, with Roe and Metro-Cammell-Weymann bodies, 120 h.p. motors, and equipped with automatic acceleration—good for bus and customer, but not so popular with drivers.

When the Notts & Derby Traction Co. abandoned trolleys Bradford purchased the entire fleet, becoming Nos. 760-774; they were BUT's with Metro-Cammell-Weymann bodies, and were first in service in Notts in 1949, coming to Bradford in 1953. Several older AEC buses from the same source were numbered back to 580-596. About the same time ten chassis were purchased from Llanelly and these are now in service in Bradford with East Lancashire bodies (Nos. 775-784).

The story of Bradford's vehicles has been told in some detail; now other systems, which came into the field later and in most cases less extensively, will be dealt with more briefly.

Actually, Dundee was the next town to try trolleys; but it was not for long. The service was opened on 3 September 1912 along the Clepington road from Maryfield to Fairmuir, with two buses by the Railless Electric Traction Co. But they met with little success, partly because the Corporation refused to make up a good road; the scheme was abandoned on 13 May 1914 and the cars sold in 1917 to Halifax.

ROTHERHAM

It was also in 1912 that Rotherham took the decision, after a trial on 23 September out to Wickersley. The service opened on 3 October the same year from Stag Inn to Maltby, with chain-drive Straker Squire buses, and like Bradford, Rotherham is still operating trolleys after all these years; so far with single-deckers, but now in 1956 they have on order fourteen double-deck vehicles.

STOCKPORT

Sometimes a Council decides it must have something different, and this happened with Stockport, which on 10 March 1913 opened a trackless system called the Lloyd Kohler or Bremen (an experimental line had been opened in Bremen in Germany) on a two-mile route between Stockport and Offerton. The 1914-18 War made maintenance of these vehicles almost impossible, so the experiment was abandoned after only three cars had been purchased. They were twenty-seat single-deckers, chain driven, with Brush

bodies and with what was a novelty at the time—a foot-operated controller. There was only one pair of overhead wires for both directions; they were mounted in vertical parallel, the two-wheeled trolley truck running on top of the upper wire (negative) and two spring-loaded bows bearing against the lower wire (positive). The flexible cable was plugged into the bus side and exchanged as the two cars passed each other.

KEIGHLEY

In the same year of 1913 the Keighley Corporation in Yorkshire decided to operate trolley buses on yet another system, the Mercedes-Stoll, an Austrian invention (there must have been quite a few deputations to the Continent that year). It opened on 24 April 1913, and until it closed down in 1932 cost the ratepayers quite a lot of money. The Cedes-Stoll system was somewhat similar to the Lloyd Kohler, the difference being that a four-wheeled trolley ran on top of the wires. Some details can be given: it was introduced on the Ingrow Cross Roads route first, and later on routes between Otley Tram Terminus and Sutton via



A Keighley Cedes Stoll in action, showing trolley equipment and pendulum balance which kept the trolley on the wires.

Cross Hills, and from High Street, Keighley to Lane Ends, Oakworth. The first run was on 24 April 1913, and Board of Trade sanction was given on 2 May 1913, this being the first time the system had come up for inspection in this country. The first cars had two 20 h.p. motors but were found to be underpowered, and later 25 h.p. motors were fitted. In 1916 the Ingrow Cross Road route was extended to Lower Town, Oxenhope, using overhead equipment which came from Hove in Sussex. It was decided however that the weight of the vehicles was too much for the roads, and the route was cut back to Cross Roads during the 1914-18 War, being reopened to Oxenhope in 1921. The weight of the buses complained of was $5\frac{1}{2}$ tons. The first car to run was an Austrian-built twenty-four-seater on loan; the motors were in the rear wheels. The experimental bus broke down within a month—a foretaste of things to come. The current collector weighed 28 lb. and wear on the wires was almost nil; the bus could operate 35 ft. away from the overhead. By 1918 only two cars out of ten were operating, due to difficulties in getting spares.

The overhead equipment was by Clough Smith of London, the car bodies by Dodsons of Westminster. One car was converted to front-wheel drive; it cost a mint of money and probably never ran in public service. At one time Keighley operated a double-deck open-top Cedes-Stoll, the only one in the country. It went on the Sutton route late in 1915 and ran until August 1920, when it ran away and crashed. This vehicle had previously been operated by Hove Corporation.

Keighley scrapped the system in August 1932; the later trolleys were Straker Cloughs with both trolleys on one base; they had 40 h.p. motors and contactor control.

RAMSBOTTOM

Ramsbottom Urban District in Lancashire obtained powers to construct a tramway in 1903; this never materialised, but in 1912 powers were sought for a trackless system. Two routes are authorised: Holcombe Brook Station-Market Place-Ramsbottom Lane-Bury Road to the finger post in Market Street (3.37 miles); and Market Place-Bridge Street-Railway Station (0.16 miles). The service was opened on 14 August 1913 with cars supplied by the Railless Electric Traction Co., single-deck, chain-driven, with solid tyres and under-running trolleys as at Bradford. There were seven of these; the service was closed down on

31 December 1930, and was the only case in this country of a trolley route operated by an authority which had never run trams.

ABERDARE

On 13 January 1914 a Cedes-Stoll system was opened in Aberdare with eight cars similar to the Keighley ones. The routes were: Commercial Street-Abernant (1 mile), Cemetery to Cwmdare (0.5 miles), Clarence Street to Caprock (0.8 miles), and Clarence Street to Cwm Aman (1.26 miles). The overhead wires were suspended by J-hooks; the trolley had four wheels in pairs mounted on a vulcanised body with a pendulum containing a coil spring, which allowed a loop of twin flexible cable to be paid out on demand and taken up when the bus returned to its normal position on the roadway. Under the bonnet of the bus was the main drum with another 25 ft. coil of wire, controlled by a flat spring. The connection between the trolley flexible cable and the bus cable was fitted with a spring clip which 'broke' at any extra hard tug, allowing the plug to separate without doing



*Cedes-Stoll
Car at
Aberdare
1914.*

any damage to trolley or wires. The trolley was hoisted by a forked pole from the top of the bus, being pushed between the wires and then lowered on to them (quite a feat). The current was collected from the main drum by laminated copper brushes on slip rings, going to the controller via BTH circuit-breakers and air-cooled resistances slung under the floor, and thence to the motors which were mounted in the wheels. The controller had seven positions forward, the first four for series working and the last three for parallel working; it also had positions for rheostatic braking and reverse. There were two foot brakes, one being fitted with

a ratchet and tongue and serving for a parking brake. The motors were revolutionary in design in that the armatures revolved exterior to the field coils. The field poles were eight or twelve in number, held in position on the axle by two long keys; the armature slid over and was fastened to a back plate. The brush gear, also on the shaft, was secured by a locking nut and lay flat vertically upon the disc-shaped commutator; it was totally enclosed in an aluminium cover with a rubber gasket to make it water-tight.

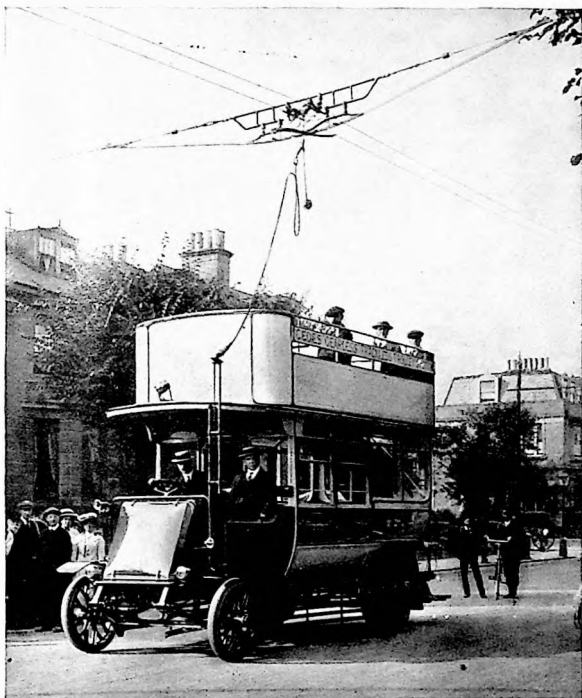
The buses were towed to their respective termini by tramcars, coupled by a spring-loaded drawbar. It was originally intended that they should go under their own power, and provision was made for a skate to lower onto the tramlines, and one pole to a single overhead lines, with a change-over switch. But for the sake of speed the idea was abandoned and they were towed. The first of the motors was made by Johnson & Phillips at Charlton and later ones in the Cedes-Stoll works at Stamford Hill. The running costs cannot be accurately quoted, but it is believed that, all things being equal, they were the cheapest (and smoothest) vehicles on the road at that time. This system was closed down in July 1925 after eleven years' running—not bad for a pioneer system.

HOVE AND BRIGHTON

To the South Coast now, to Hove—and, yes, another Cedes-Stoll system, but this time with a double-decker. The Council decided they wanted a trolley-bus ride, so the clerk was instructed to ask the Cedes-Stoll Electric Traction Co. to fit up an installation, bring a bus, and let them have a go. The first run was on 16 September 1914, from Hove

*Experimental
car at
Brighton
in 1914.*





Courtesy]

[Hove Borough Library

The Cedes-Stoll trolley bus on trial in Hove, Sussex.

Station to a point east of the Town Hall, via Goldstone Villas and George Street. The bus carried thirty-two passengers and ran with a continuous hissing sound which apparently annoyed those on board. It was again run on 18 September for the Brighton Town Councillors; the deliberations as to whether to have a permanent service went on until 9 August 1915, when the Clerk was instructed to have the installations removed. The whole thing cost the ratepayers £600.

At next-door Brighton a trial was carried out with the

first double-deck car made by the Railless Electric Traction Co., over a third of a mile on the London Road, for the benefit of the Town Councillors. The system used was the Schiemann under-running one, and the first run was probably made in December 1913, but definitely the bus was out on 6 January 1914 showing off to the Brighton Council, and on 14 January for the Hove Council. It is not certain what happened, but the bus turned up later at the Kirkstall Road Works of Leeds Corporation. Brighton came back to trolleys many years after.

RHONDDA

Again we go to Wales, where the Rhondda Urban District Council, who operated trams, were asked in September 1912 to start a bus service from Williamstown to Tonyrefail and Gilfachgoch, to take workers to a new pit. A deputation went to Rotherham to study 'Railless', and it was decided to start a service with six buses, with underrunning trolleys, made by Brush. The overhead gear was by the National Electric Co. The route from Williamstown to Gilfach was opened on 14 December 1914, but owing to bad roads and subsidences the service was abandoned after three months—and so ended another short-lived effort.

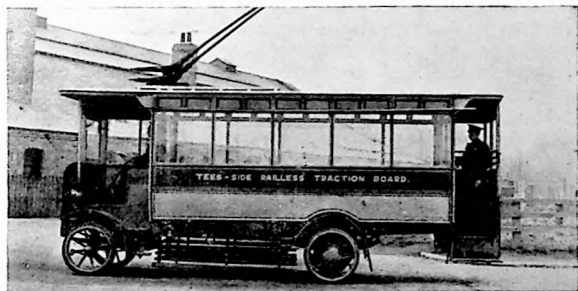
MEXBOROUGH

The next system was that of a BET-controlled company, the Mexborough & Swinton Traction Co., who operated trams in the area, and on 21 August 1915 opened a trolley route, with overhead construction by National Electric Construction Co., between Mexborough and Manvers Main Colliery and between the Old Toll Bar and Conisborough. The cars were single-deckers with Daimler chassis and Brush bodies. In September 1922 they were replaced by AEC single-decks and during 1928 Garrett single-decks were put into service. The Mexborough system was extended to Swinton on 10 March 1929. The trams were withdrawn, and a through service of trolleys instituted between Rotherham and Conisborough. A short extension was opened on 28 June 1931 into Aldwick Road, Mexborough, to provide a terminal point off the narrow streets, and on 15 October 1934 another extension was opened in the Rawmarsh urban district, making a total route-mileage of 12.63 miles. The Garrett buses were powered by 65 h.p. twin-armature series-wound Bull motors. In 1943, six new buses were purchased: single-deck centre-entrance Sunbeams with Brush bodies

and BTH equipment. Further replacements were added later and the company is now operating 39 Sunbeam-Brush single-deckers. The centre-entrance bodies have thirty-two seats distributed between two saloons, with manually-operated folding doors and electric heaters in both saloons and driver's cab.

TEESSIDE

The Teesside Railless Traction Co. opened the first of the post-war systems on 8 November 1919, and it is still operating. Originally called the North Ormsby, South Bank, Normanby and Grangetown, the route was 5 miles 176 yards long. Clough Smith supplied the overhead gear, and there were ten buses by the Railless Company, single-deckers with two 23 h.p. motors, each driving one rear



'Tees-side' Railless Car of 1919.

wheel through worm reduction gearing. The service brakes worked on the rear wheels, by hand and foot, with an emergency brake on the transmission by foot only. The Teesside Co. ran a petrol-electric trolley bus in 1924, designed by the manager; it was numbered 22 and built by Tilling Stevens.

YORK

In 1920 York started a trolley route from Heworth to the Pavement; in 1930 it was closed down, but reopened the following year with more up-to-date vehicles. Trials were made on this system with a six-wheel bus having a Karrier chassis and Roe body, with motor and contactor control

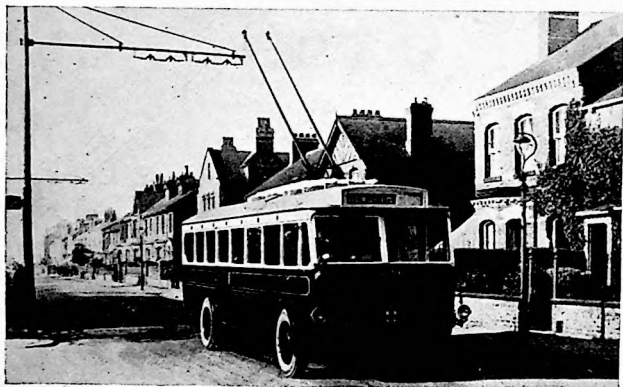
*One of the
first cars in
York
(Railless
Traction
Co. 1921).*



by BTH. There was one 65 h.p. 500-volt motor and the trolleys were on separate bases. York abandoned trolley buses in 1935.

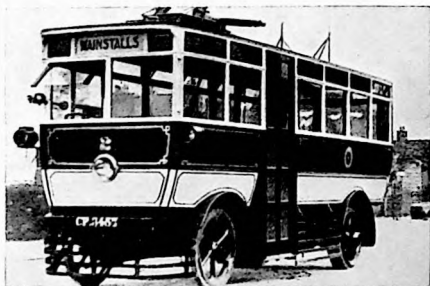
HALIFAX

In May 1903 the Transport Committee investigated the Schiemann and gave instructions for a car to be built, but it came to nothing. In 1918 they purchased two trolley buses from Dundee; they did not run in service, but were to be converted to lorries using a single boom and running over tram routes; it was estimated they could carry 5 tons at 10d. per mile, which was cheaper than petrol, but this



Trolley bus in York after the service was restarted in 1931.

*Halifax
Corporation
Tilling -
Stevens
of 1921.*



came to nothing too. Nothing daunted, in July 1921 they acquired two Tilling Stevens trolley buses with solid tyres, weighing $2\frac{1}{2}$ tons and fitted with 25 h.p. motors. The bodies were built by the Corporation. These were originally numbered 193 and 194, on the end of the tram list, but before going into service on the Pellon-Wainstalls route they were renumbered 1 and 2. In 1926 it was decided to end the experiment and on 24 October motor buses replaced the trolleys.

BIRMINGHAM

Birmingham Corporation was the first authority in this country to change a tram route over to trolley operation; this was the Nechells route, on 26 November 1922. Shortly before a deputation had gone north to Bradford to examine the system and to ride in No. 521, the only top-covered double-deck then running. They must have given a good report, for the Nechells cars were of this type, the first regular fleet with covered tops to be used. They were numbered 1 to 12, and ran until 30 September 1940. Built by the Railless Electric Traction Co., with 51-seat Roe bodies, they had open stairs.

There followed No. 13, an EMB with 48-seat English Electric body, built in 1924; Nos. 14, 15, 16 of 1926 were AEC's with 51-seat Short bodies. No. 17, the last with open stairs, was also built in 1926 by AEC, with Vickers 52-seat body. No. 18 was a Guy six-wheeled with Guy 53-seat body (1930); No. 19 (Leyland) and 20 (Guy) were



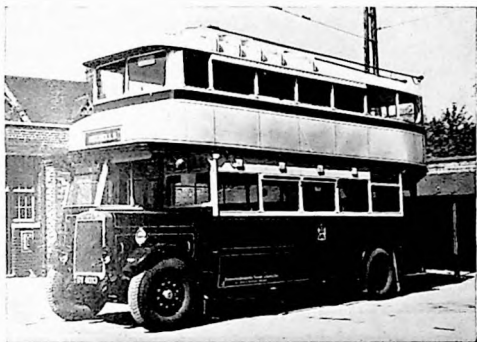
Courtesy]

[Birmingham City Transport

One of the cars for working the Nechells route in Birmingham, 1922.

48-seaters (1931). There was also another No. 19, a Guy RTX six-wheeler, which never ran in public service.

After these came a new series 1-11, Leyland Titans with Short bodies and GEC WT25 motors. These buses had half-cabs and normal motor-bus bonnets and radiators. Nos. 12-16 were AEC six-wheelers with 58-seat Short bodies, built 1932. Early in 1933 a 60-seat Leyland (No. 17) was supplied; it went back to the makers after a few months, but in 1936 returned as No. 68 and ran until the following year. Early in 1934 a batch of fifty buses appeared, Nos.



*Leyland Titan trolley bus in Birmingham 1931:
note normal 'bus radiator.*

16-66, Leyland TTBD2 six-wheelers with 58-seat Metro-Cammell-Weymann bodies. In the same year came No. 67, a Sunbeam MS2 six-wheeler with M-C-W body. Being not standard to the fleet it was sold to Wolverhampton, becoming No. 222 in that fleet. Nos. 67-78 (1937) were Leyland TB5's with 53-seat M-C-W body, and Nos. 79-90 (1939) Leyland TD7's with 54-seat M-C-W body. Birmingham abandoned trolley buses in 1951.



[J. C. Gingham

Leyland-MCW in Birmingham 1934.

WOLVERHAMPTON

In 1922, the Wednesfield tramway having reached the end of its useful life, experiments were made with trackless operation, following experience with petrol-electric buses.

On 29 October 1923 Wolverhampton began operating trolley buses (single-deck Tilling-Stevens with 36-seat Dodson bodies). Powers were then sought to convert all the Corporation's tramways, and to purchase tramways running outside the limits to Willenhall, Bradley, Bilston, Darlaston, Sedgley, and Dudley. All, with the exception of Bradley, and with the addition of routes to Bushbury Hill, Cannock Road, Amos Lane, Fordhouses, Merry Hill and Finchfield were equipped for trolley buses. The local firm of Guy Motors introduced in Wolverhampton the first six-wheeled vehicle fitted with Stevens regenerative motor. This town has made great strides since, being fortunate in having the Sunbeam works on the door-step. By 1933 ninety-five buses were operating over a total of 40 route-miles, and the total is now 49 miles and 160 cars.

IPSWICH

Ipswich was the next to operate trolleys. The Council arranged to loan three cars from the Railless Co. at a cost of £700. The test was carried out on the Cornhill to Ipswich Station route, and running started on 2 September 1923.



Ipswich Corporation trolley Bus, 1923.

As it was a tram route, only a negative wire had to be erected. They were pay-as-you-enter cars with twin motors and twin differentials. The tests were a success and Ipswich carried on with conversion, so that by 1926 trolleys had taken over from the trams. Today the fleet numbers sixty.

OTHER PROVINCIAL SYSTEMS

Wigan was next in the field, starting a trolley service on the narrow-gauge Martland Bridge tram route on 7 May 1925. The cars were 37-seat single-deck centre-entrance Straker-Cloughs with both trolleys on one base, 40 h.p. motors, BTH contactor control and Brush bodies.

On 12 August 1925 Ashton-under-Lyne started a trolley service and now operate twenty-one cars; at about the same time Southend decided to experiment with two 'Railless' cars along Victoria Avenue, from Technical Schools to the Junction of West Street. They were 34-seat centre-entrance single-deckers with 42 h.p. English Electric motors and pedal type control. After this trolleys were extended to other parts of the town. The fleet was built up to thirty-three, but three single-deckers were scrapped in 1952, and double-deck No. 16 was converted into a mobile toilet. There were eleven AEC's with E.E., Strachan and Brush bodies, and eighteen Sunbeams with Park Royal bodies. There was also a bus built by the Gloucester Carriage & Wagon Co. (the only one they ever made), a double-decker with Crompton 65 h.p. two-axle motor, contactor control

*Maidstone
Corporation
Ransomes
Car.*



(eight notches) and vacuum brake on all wheels. It was No. 122 and very similar in appearance to the AEC Q type.

Darlington on 4 October 1926 began running a fleet of twenty-six Karriers and eleven Leylands, all centre-entrance. Grimsby joined the ranks of trolley operators in the same month, and had completely changed over by 1936; the fleet now consists of ten AEC and nine Karrier double-deckers. Nottingham was the next in 1927, and today has a fine up-to-date fleet of 150 buses. In February the same year West Hartlepool put trolleys on the Foggy Furze route: 'Railless' cars with 42 h.p. 525-volt motors.

Chesterfield had studied trolleys in 1912, but it was not until 19 May 1927 that the first trackless route was opened, from West Bars to Brampton terminus, with cars by Clough Smith and also some by Ransomes Sims & Jefferies. The service was abandoned in 1938. Maidstone decided to run trolleys in May 1928, the Barming route being converted, and since then trolleys have taken over new routes year by year. The first cars were double-deckers by Ransomes Sims & Jefferies. Maidstone still operates nineteen trolley buses. Hastings on 1 April 1928 began a six months' experiment with eight six-wheelers. Today, after twenty-six years, the Corporation still operates one of these old open-tops for sea-front running.

On 22 August 1928 Doncaster replaced trams on the Bentley route with six-wheeled trolleys seating sixty. This town now operates a fleet of forty-four trolleys of Karrier and Sunbeam make. On 18 September 1930 trolleys replaced the Pontypridd trams on the Treforest to Cilfynydd route. One of the only two trolleys built by the Bristol Tramways concern was run here (the other was at Doncaster). It is believed the cars were tested on overhead wires erected at the Brislington tram depot. The South Lancashire trams began to be replaced by trolleys on 30 July 1930, and by 1933 had been entirely superseded; there are now seventy trolley buses of Guy, Karrier, Leyland and Sunbeam make; four cars owned by Bolton Corporation are operated and maintained by SLT.

LONDON

It may seem odd that London was so late in operating trolleys, but it must be remembered that wires were not permitted in the centre, and suitable sites for trolley run-rounds were hard to find in the congested streets where the various tram-routes terminated. Indeed it was well out of the City that on 16 May 1931 the first cars ran, replacing trams on London United's Twickenham to Teddington route. These were six-wheelers with AEC chassis and bodies by the Union Construction Co. of Feltham. In front was a bonnet like a bus, containing an 80 h.p. BTH motor; but the general appearance and the headlamps were tram-like. There was rheostatic and vacuum servo braking; the current collection was by trolley wheel heads, which caused excessive noise and were later replaced by a sliding type. These buses had the nickname 'Diddlers' and were class A1; class A2 was very similar.

Soon after the LPTB was formed, it became clear that a super trolley bus would be required to replace the 74-seat trams if overcrowding was to be avoided. The LUT had already prepared the way with what became class X1, an AEC-UCC 74-seater with centre entrance (No. 61), and class X2 (No. 62) by AEC M-C-W, and class X3 (No. 63) by AEC-English Electric, the only four-wheeler in the fleet.

Space does not permit dealing fully with the London fleet, but the following gives a resumé of the classes:

B1	Leyland—Birmingham R.C. & W.	...	...	...	67 cars
C1	AEC—Birmingham R.C. & W.	...	...	...	52 cars
C2	AEC—M - C - W	...	...	...	100 cars
C3	AEC—Birmingham R.C. & W.	...	...	...	98 cars
D1	Leyland chassisless prototype				
D2	Leyland chassisless	...	...	...	92 cars
B2	Leyland—Birmingham R.C. & W.	...	...	...	65 cars
D3	Leyland—Leyland	...	...	...	47 cars
E1	AEC—Brush	...	...	...	50 cars
E2	AEC—Park Royal	...	...	...	25 cars
E3	AEC—M - C - W	...	...	...	25 cars
F1	Leyland—M - C - W	...	...	...	100 cars
X3	AEC—English Electric (four-wheel)	...	...	...	1 car
X4	AEC chassisless prototype				
H1	Leyland—M - C - W	...	...	...	147 cars
J1	AEC—M - C - W	...	...	...	48 cars
L1	AEC—M - C - W	...	...	...	1 car
L2	AEC—M - C - W	...	...	...	1 car
J2	AEC—M - C - W	...	...	...	75 cars
J3	AEC—Birmingham R.C. & W.	...	...	...	25 cars
K1	Leyland—Leyland	...	...	...	100 cars
K2	Leyland—Leyland	...	...	...	100 cars
L1	AEC chassisless—M - C - W	...	...	...	14 cars
L2	AEC chassisless—M - C - W	...	...	...	9 cars
X5	AEC chassisless—L.P.T.B.*	...	...	...	1 car
L3	AEC chassisless—M - C - W	...	...	...	144 cars
M1	AEC chassisless—L.P.T.B.	...	...	...	25 cars
N1	AEC—Birmingham R.C. & W.	...	...	...	90 cars
N2	AEC—Park Royal	...	...	...	24 cars
X6	AEC chassisless—E.E.	...	...	...	1 car
X7	Leyland—Leyland†	...	...	...	1 car
K3	Leyland—Leyland	...	...	...	25 cars
P1	Leyland—M - C - W	...	...	...	25 cars
SA1	Leyland—M - C - W (8 ft.)	...	...	...	12 cars
SA2	Leyland—M - C - W (8 ft.)	...	...	...	13 cars
SA3	AEC—M - C - W (8 ft.)	...	...	...	18 cars
Q	BUT—M - C - W (8 ft.)	...	...	...	77 cars
Q1	BUT—M - C - W (8 ft.)	...	...	...	50 cars

* Designed for Kingsway Subway, with entrance on both near and off side.

† Four-wheel steering.

Classes SA1 and SA2 were ordered for Durban in South Africa but detained over here owing to the War.



*Ex-LUT
'Pay-as-you-enter'
bus, class
X2.*

LLANELLY

Returning to the provinces we must go back to 26 December 1932, when the Llanelly & District Electric Supply Co. decided to replace its trams with trolley buses; the first route to be changed over was that between Llanelly and Loughor. Resulting from the Electricity Act of 1947, the company, including the traction element, became vested in the South Wales Electricity Board, which continued to operate the trolley system until 22 March, 1952, when the South Wales Transport Co. (one of the BET group) took them over, and in October the same year abandoned the trolleys in favour of motor buses. The trolley fleet comprised nine Leylands and twelve Karriers with bodies by Roe, Park Royal and Brush. Two of these buses are now running at Maidstone in original condition. The rest of the chassis were bought by Bradford, who are now running them with East Lancashire bodies.

NOTTS AND DERBY

The history of the Notts & Derby Traction Co. begins with the opening in 1902 of the Ilkeston Tramways, although these were not incorporated into the Notts & Derby until 1917. Powers to operate trolley buses were granted in 1928; the tram services were suspended and single-deck trolley cars introduced on the Loscoe, Heanor to Ilkeston and Hallam Fields Roads on 1 August 1932. On 5 October 1933 double deck trolley buses were put on between Ripley and Cinder Hill. Seven AEC-English Electric vehicles were added in 1937, and ten more in 1941-42. These had been ordered before the War and then 'frozen'; later permission

was granted for them to be finished. Fifteen BUT four-wheelers in 1949 replaced the 1933 buses; in 1952 abandonment was decided upon and the entire fleet sold to Bradford, where they are now running.

FURTHER CONVERSIONS

Walsall started a trolley service in 1931 with two AEC's with highbridge bodies, followed by two BTX type Guys; the fleet now numbers forty-nine.

In 1933 Huddersfield converted the Almondbury route to trolley operation; six buses were purchased and they first ran on 4 December: a mixed bag of Karriers, Sunbeams and Ransomes with bodies by Park Royal, Brush and English Electric. Next year the Outlands, Lindley and Waterloo routes were converted. Trams were finally abandoned in 1940 and the trolley fleet now numbers 140, Karriers and Sunbeams.

Derby Corporation started to operate trolley buses on 9 January 1932, six-wheeled double-deck Guys with regenerative 75 h.p. motors, Guy control gear and BTH contactor panels. This town now has a fleet of seventy cars.

To the South Coast again: Bournemouth chose for an experiment in May 1933 the route from the Square to County Gates, and the trolleys were an immediate success. They comprised two AEC's (one six-wheel, one four-wheel, both double-deck), a six-wheel Sunbeam double-deck, and



*Ex - LUT
Class X3,
London's
only four-
wheeler.*

the only single-deck Brush-Thornycroft ever made. The twelve months' trial did not cost the ratepayers a penny, and tramway abandonment was proceeded with. A fleet of Sunbeam-BTH six-wheelers was ordered, later supplemented by a batch of BUT cars. The yellow colour makes a vivid impression and the fleet is a pleasure to see.

Just along the coast in Portsmouth trolley-buses were introduced in 1934, on the Cosham Railway Gates, Kingston Road, Fawcett Road, South Parade and Pier route. The first five cars were all different for experimental purposes: from them has been evolved the navy town's 'silent service' of today.

A little farther east, to Brighton: this town decided to have another go, and in 1935 borrowed a trolley bus from Portsmouth; but it was not until 1939 that the Corporation began a regular service. The fleet now numbers sixty.

The following towns not previously mentioned also now operate trolley buses: Newcastle (1935), South Shields and Reading (1936), Hull (1937), Cleethorpes, Manchester, Belfast (1938), Cardiff (1942) and Glasgow (1949).

There have of course been many interesting experiments in the trolley bus field; a vehicle worthy of note was tested at Wolverhampton on 18 September 1932. Built by the Gilford Motor Co. of High Wycombe and the Electric Construction Co. of Wolverhampton, it was a front-wheel-drive double-decker of one-motor design, with control gear in front of the driver; a door on the front opened up to give access to it. There were Lockheed brakes on all wheels, also electric and regenerative brakes. Another interesting trolley bus had a cash desk for the conductor, who sat still; a turnstile on the top deck kept him mechanically informed when the deck was full. The public, however, did not take kindly to it.

So ends for the moment the story of the trolley bus as it evolved in Germany and the U.K.; it must not be forgotten that trolley vehicles won success in scores of other countries all round the globe. Although some abandonments are now taking place, there is no doubt that the railless system still has a great part to play in passenger transport.

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